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ABSTRACT

There are several educational, social, and economic trends that converge to increase the need to understand how adolescents can best become more involved in the education of younger children. Many educators have pointed to the benefits of the rich and complex learning that occurs during cross-age tutoring. Current reforms in public school education feature an emphasis on teenage service to the community, including younger children, as an integral part of the high school program. Increased demands on parents to work outside the home have opened up new requirements for after-school day care for young children who can benefit from cross-age instruction. The literature on adolescents as educational instructors has emphasized the more limited role of "tutor" of material already presented rather than "teacher" of material new to the learner. This limitation has been described as being due to a restricted range of instructional moves, lack of sophistication in the tutor, and curricula which do not focus on the specific skills of the adolescent as an instructor. There is a need to better understand the potentialities of adolescents as science instructors for younger children. The purpose of this study done by the 4-H Youth Experiences in Science (YES) Project is to illuminate the interactions and other dynamics of adolescents as teachers in a science curriculum that was planned to use teenagers as the primary instructional source teachers rather than merely as tutors. This study found that the nature of child science (the instructional goal) was particularly well suited to the instructional strengths of teenagers. The adolescents were found to be effective at initiating exploration, play, manipulations, and testing of ideas and materials, all primary goals of child science learning. The implications of this study are important so that educators can plan curricula to take advantage of adolescents as effective instructors of child science. (Contains 29 references.) (DKM)

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ADOLESCENTS AS EFFECTIVE TEACHERS OF CHILD SCIENCE

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There are several educational, social, and economic trends in this country which converge to increase the need to understand how adolescents can best become more involved in the education of younger children. For example, many educators have pointed to the benefits of the rich and complex learning that occurs during cross-age tutoring (Good & Brophy, 1987). Current reforms in public school education feature an emphasis on teenage service to community, including younger children, as an integral part of the high school program (Decker & Romney, 1992; Ponzio & Fisher, 1995). Additionally, increased demands on parents to work outside of the home have opened up new requirements for after-school day care for young children who can benefit from cross-age instruction (Coontz, 1992).

The literature on adolescents as educational instructors has emphasized the more limited role of *tutor* of material already presented rather than *teacher* of material new to the learner. Many researchers have found that the kind of learning best accomplished by teens is review of previously learned material, rather primary source instruction. This limitation has been described as due to a restricted range of instructional moves, lack of sophistication in the tutor, and curricula which do not focus on the specific skills or effects of the teen as an instructor.

There is a need to better understand the potentialities of teens as science instructors for younger children. The purpose of this study was to illuminate the interactions and other dynamics of adolescents as teachers in a science curriculum that was planned to use the teens as primary instructional source teachers, rather than merely as tutors. Information from this study is important so that educators can plan curricula to take advantage of adolescents as effective instructors of child science.

BACKGROUND

Adolescent Teaching and Psycho-Social Growth

Erikson (1968) described the psycho-social growth of children and adolescents as two distinct phases of life which each require their own challenges and opportunities. For children, it is important to actively develop one's own competence in doing the things that are done in the society. This means that children benefit from doing the things that scientists, technologists, and inventors do, and by manipulating the materials and ideas in their environment. For adolescents, psycho-social growth means taking on the roles of teacher and leader, and otherwise building an identity that fits into the important needs of society. Erikson described the remarkable

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effectiveness of adolescent participation in terms of *identity formation*, development of *integrity*, and devotion to *fidelity* characteristic of adolescence. These characteristics are important because they forecast the potential benefits of using adolescents as teachers. Teenagers are in a life stage where their exploration of identities ("teacher," "leader of others," "contributor to society") all can be carried out in the framework of science teacher. What is needed is adult structuring of programs that match the teenagers with the opportunity to readily put these adolescent tasks into practice. In this situation, "readily" means short-term, economical, feasible, but above all *authentic* opportunities for adolescents to carry out these psycho-social developmental tasks.

Sabin (1976) described how the tutor-tutee relationship is ideal for positive and mutual support for growing and learning. Sociologists such as Goodman (1960) and Friedenberg (1959) have described how adolescents are relatively isolated in this society from real work and dealing with the needs of other people. Teens are considered by many adults to be a nuisance, undependable, erratic, self-centered, and better isolated from the real work of the community and society. This study focused on the characteristic behavior of adolescents as they acted out their psycho-social role as teachers of child science. This role of teacher in a child care setting placed adolescents at a place of genuine need in their society.

Empirical Studies of Adolescent Tutoring

Despite a long tradition of cross-age tutoring in school and non-formal educational settings, and with strong support from practitioners, the empirical research literature about the effectiveness and theoretical backing for having teens teach children is neither complete nor strong (Barron & Foor, 1991; Deven-Sheehan, Feldman & Allen, 1976; Good & Brophy, 1987). Most studies on the topic have been described as non-systematic and overly simplified in treatment of variables. The findings have been blandly positive, but have not been exciting in terms of effective learning or teaching.

Researchers have investigated the empirical application of different conceptual themes of teens as tutors. For example, Fogarty and Wang (1982) found that tutoring sessions characteristically are friendly, enjoyable, and helpful. They described the successful tutor's role as based more upon friendship than a traditional teacher-like authority. The interpersonal dynamics are a kind of give and take around the subject matter. A great strength of tutoring is that a kind of cooperative learning situation is formed in which both the tutor and tutee carry out roles that require each other. The authors reported the point of view that tutors have a limited instructional repertory, unless specifically taught, and therefore should be expected to be limited in their effectiveness.

Cohen, Kulik, and Kulik (1982) found that cross-age tutoring is an instructional strategy associated with positive achievement and attitude gains. They concluded, however, that results are mixed and not always exceptionally strong. Levin, Glass, and Meister (1987) found that tutoring was cost effective in relation to computer assisted instruction and lengthening of instructional day.

Good and Brophy (1987) reported that cross-age tutoring is commonly found in elementary schools, although usually of the upper grades-lower grades configuration rather than using teens. These authors described the advantage of cross-age tutoring as sessions that provide a change of pace from usual instruction. Much of the effectiveness of tutoring comes from the dynamics of interpersonal relations. For example, younger students are more likely to ask for needed help rather than to feign competence and remain silent, as they may do in the presence of intimidating adults. Also, interpersonal conflicts between teens and children are rare and more easily avoided. Other benefits derive more directly from the instruction itself; for example, student tutors may use language or examples that are more easily understood than those of adults. Also, the tutor's recent experience of problem-solving may help them to better assist

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children. Good and Brophy continued the idea that cross-age tutoring is more effective for supervised practice and follow-up, rather than more sophisticated stand-alone instruction.

Barron and Foor (1991) found that specific training programs are essential to tutoring program success. They reviewed the extensive literature that suggests that tutors need training in (1) general principles of teaching, (2) focused and practical instruction in specific methods of guidance, (3) specific training in use of program materials and procedures, and (4) "elaborated" training about the underlying rationales and principles guiding the instructional procedures. These researchers found that tutors who have a full understanding of the task and its rationale are better prepared for learning or performing the task themselves, and better equipped to manage the demands of the task when required to instruct others.

THE STUDY

Youth Experiences in Science (YES) Program

The teenagers and children in this study participated in the 4-H Youth Experiences in Science (YES) Project which provides children's science in after-school care settings for children age five to eight. 4-H YES offers planned, thematically linked science education experiences geared to the needs of children and child care providers. The six thematic units are: making and studying bubbles, collections leading to a mini-museum, snail investigations, kitchen science, earthworm culture, and recycling. Activities in these units provide hands-on science meaningful to this age group. The activities and processes have real-life applications and use inexpensive and readily available materials. For example, in recycling children learn how to use discarded objects to make toys. Each curricular unit includes five to ten two-hour sessions of sequenced activities, information, and instructional guidelines.

The child science provided for in the YES curriculum emphasizes age appropriate designs (Chaille & Britain, 1997; Chaille & Silvern, 1996; Metz, 1995, 1997). It includes opportunities for play, exploration, fantasy, hands-on inquiry, mutual observation and support, individual inquiry, cooperative inquiry, construction of materials and ideas, and manipulation of materials. It also includes information and invitations to extend activities and thinking to later experiences with family and friends.

The teenage volunteers attend ten hours of training led by professional educators. The teens learn to lead one or more of the curricular units by doing, reading, and talking about them. Under the supervision of an adult volunteer/coach or staff the teens conduct the activities with elementary school-age children and plan the family activity programs at participating child care sites. Teenage volunteers contribute approximately 20 hours preparing and conducting the 4-H YES Project activities. This model has demonstrated its effectiveness for both teen leaders and youth participants (Ponzio & Fisher, 1995).

A current theme of school curriculum development is service learning. Ponzio and Fisher (1995) gave four arguments for the desirability of teens as teachers. First, teaching permits teens to "appropriate what they have learned in a meaningful way," an important component of profound learning. Second, the teens' voices are given a broader context than the individual school classroom. Third, high school students are enabled to make an authentic contribution to their communities: the science instruction is a genuine improvement over child care that merely entertains, monitors, or "warehouses." Finally, science education as teaching enables the part of science that is social in purpose to be expressed.

Training Strategies

The training sessions bring together the teen volunteers, their adult 4-H mentors, and the School Age Child Care (SACC) staff. All participants are treated as equal contributors, and seating/activity arrangements are made to co-mingle the teens and adults. A friendly environment

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with introductory "ice breaking" activities and food assists in forming positive attitudes about science, teaching, and learning.

Training is designed for two sessions, three hours on a Friday evening followed by an eight hour Saturday session. Four key ideas are presented through hands-on activities in the first session: (1) science is experiential (rather than merely verbal), (2) a learning cycle of thinking and doing is followed, (3) science processes (e.g., observing, comparing, relating) are incorporated with content learning, and (4) developmentally appropriate (i.e., age related) educational practices are followed. The second, full-day session is for teens to experience the curriculum activities themselves and to practice teaching.

The idea of experiential science is introduced by having participants do discovery learning with bottles, vinegar, and baking soda. Simple instructions to manipulate the materials are followed by open-ended discussions in which the empirical and speculative nature of hands-on science is experienced. Teams are encouraged to continue their inquiry in unique ways. The attitude of exploration is the common introductory thread of YES activities.

Training in developmentally appropriate practices is crucial to the success of the YES Program. Participants begin this preparation by being led through a process of "remembering when you were five to eight years old!" Next, information that outlines the general characteristics, capacities, and implications of a childhood stage of life is presented, discussed, and illustrated. Particular physical, mental, emotional, and social characteristics are addressed. For example, the ego-centric nature of five-year-old "sharing" is made distinct from that of an adolescent, and the child's need for movement during learning is included in training activities.

METHODS

A variety of data sources were used in this study to uncover the effective dynamics of adolescent instruction. Initial constructs of teen teaching and effectiveness were begun with session observations, content analysis (Borg & Gall, 1984) of videotapes of sessions, and content analysis of teen instructor portfolios. A second data gathering method was to interview children several days or a week after the activity using photographs of the child in action. During this procedure children were asked to describe what they were doing, why they took those actions, and what influence the teen instructors had on the children. In these sessions children talked about the science they learned (Gallas, 1995), the role of teens in learning science, and their uses for what they had learned with families, friends, and at school. The purpose was to elicit child thinking and intent. These interviews were audio taped and verbatim transcribed. In the third stage of data gathering, interviews of children, adult participants, and teenagers themselves focused on "why the teens were good teachers of science." Finally, the framework of findings was clarified in focus groups (Krueger, 1988) of teenagers who commented on the ideas presented to them. Videotaping and interviews were conducted by local evaluation staff. Follow-up interviews and videotape analysis were conducted by the project evaluator.

In all of these data gathering techniques, key repetitive ideas and themes were conceptually organized. The comparative question was the advantages of adolescents relative to the service of adults.

FINDINGS

Content analysis of interviews, observations, videotapes, focus groups, and portfolios identified five reasons for adolescent effectiveness which are presented in Table 1. Figure 1 depicts these reasons in a concept map that includes supportive factors to the five central reasons.

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Table 1. Reasons for Teenager Effectiveness as YES Science Teachers

Apt to do activities themselves
Relate well with children
Are valued by children
Approach is positive, confident, certain
Are less apt to restrain children

I. Teenagers are Apt to Do Science Activities Themselves

The teens are seen as much more likely to do the science activities themselves, as opposed to merely talking about them, presenting them, or directing only the children to do them. The teens were seen to transform the given materials and phenomena to their own directions and purposes. This direct participation of teens in the inquiry activities was seen as an invitation and desirable example. On the other hand, adults were characterized as task managers and bystanders who already knew the answers, as well as the questions.

II. Teenagers Relate Well With Children

II.A. Understand Children

Teens are able to understand children because they have current common experiential links that adults lack. For some of the teen instructors, there may be only a four year difference in age. They are more likely than adults to think the way children do. Teens react to authority and opportunity like children do. Both age groups are still in school and still do school activities. Members of each group ask the other about what schools they attend and if they are involved in soccer, football, or other school activities. Many teens report that they have daily contact with their own sisters and brothers the age of the child participants.

II.B. Communicate Well With Children

The reported understanding of children interacts with another teen ability to communicate with children through talk, listening, and non-verbal cues. There is general agreement that teens use their understanding and communication links to get across directions and subject matter, convey intent and enthusiasm, recognize and reward desirable participation, and monitor and adjust instruction to match child needs. This ability is in distinction to adults who have more difficulty in communicating scientific information, processes, and attitudes to children.

III. Teens are Valued by the Children

III.A. Teenagers are a Desirable Age Group for Children

Children identify teenagers as an attractive, interesting, esteemed, and valued age group. They attend to teens as important and likable persons. They are curious and fascinated about teen appearance, life, and styles.

III.B. Teens are Novel Presenters

Children are familiar with adult presenters as classroom teachers, child care center staff, and activity directors. Children are used to adults as instructors. In contrast, teenagers represent a novelty as instructional leaders. They have all of the advantages of outside speakers: credibility, interest, freshness, and newness. The relationship of child and teen instructor is described as "a new toy." As a result, the children pay greater attention and are more apt to comply and follow the modeling of the teen instructors. The role appears to children to be short term, and not just to become familiar with because it is what will happen from now on.

IV. Teenagers Approach is Positive, Confident, Optimistic, Certain, and Shows Fidelity

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Teenager performance in the YES program was described by all participants as positive, upbeat, confident, and sure. In addition, the teen instruction showed a kind of *belief* that Erikson described as fidelity, which is characteristic of adolescent behavior. This optimistic performance emphasized accomplishment rather than reserve and caution. The teens demonstrated a certainty of progress in understanding not unlike that of science itself. This approach modeled the confidence exhibited by adult scientists as they continue their work in spite of setbacks, lack of current knowledge, uncertainty of time demands, and lack of colleague reassurance. The drive for adult scientists is experience in the method of their inquiry. The drive for adolescent instructors is the characteristic fidelity of living out a role.

V. Teenagers are Less Apt to Restrain Children

Teenagers are seen as less likely than adults to restrain the initiative, behavior, and learning of children. The teens appear to use less coercive control and to present fewer inhibitions to the children. As a result, children are able to participate with less concern about possible transgressions and need to please adults. They also seem to associate the activities with less negative and controlling interaction. These attitudes may contribute to a kind of greater intellectual freedom--and consequent enhanced interaction and learning. These lessened restraints come from two areas of lessened responsibility on the part of the teens.

V.A. Teens are Not Responsible for Discipline

Teens are seen as not having the prime responsibilities for controlling, getting compliance, and disciplining errant behavior. As a result, their behavior seems to children to be less intimidating. Since the "kids don't look at them as adults," they feel less likely that "they are going to get into trouble" with them. Teens are seen as "less adversarial" and not as much "authority figures." They are not merely "instructors, telling kids what to do."

V.B. Teens are Not Responsible for Overall Program Results

A further advantage of teenagers as teachers in YES is that they are able to focus on the immediate science activities and sessions with no responsibility for the overall program. They are able to rely on adults--coaches, parents, center staff, and project leaders--to see that details extraneous to the science instruction are taken care of. The teens can leave the sessions--and leave the problems of the setting, while adults cannot. Thus, teens can be less inhibiting because they do not have to consider as many features as do the adults. The result is that their instruction can be more concentrated, focused, certain, and "straight ahead."

SUMMARY AND DISCUSSION

Previous literature reported teen cross-age tutoring to be limited in effectiveness due to unsophisticated instructional strategies. However, this study found that the nature of child science (the instructional goal) was particularly well suited to the instructional strengths of teenagers. The adolescents were found to be effective at initiating exploration, play, manipulations and testing of ideas and materials--all primary goals of child science learning.

Designers of the 4-H YES program held higher expectations for the tutors involved in their program. They sought to achieve instructional results that uniquely used the advantages of teenage teachers, and to foster scientific learnings at the optimum for the age level of the children involved. Careful studies of the results of the YES program suggest that these ambitious goals for effective teaching have been realized.

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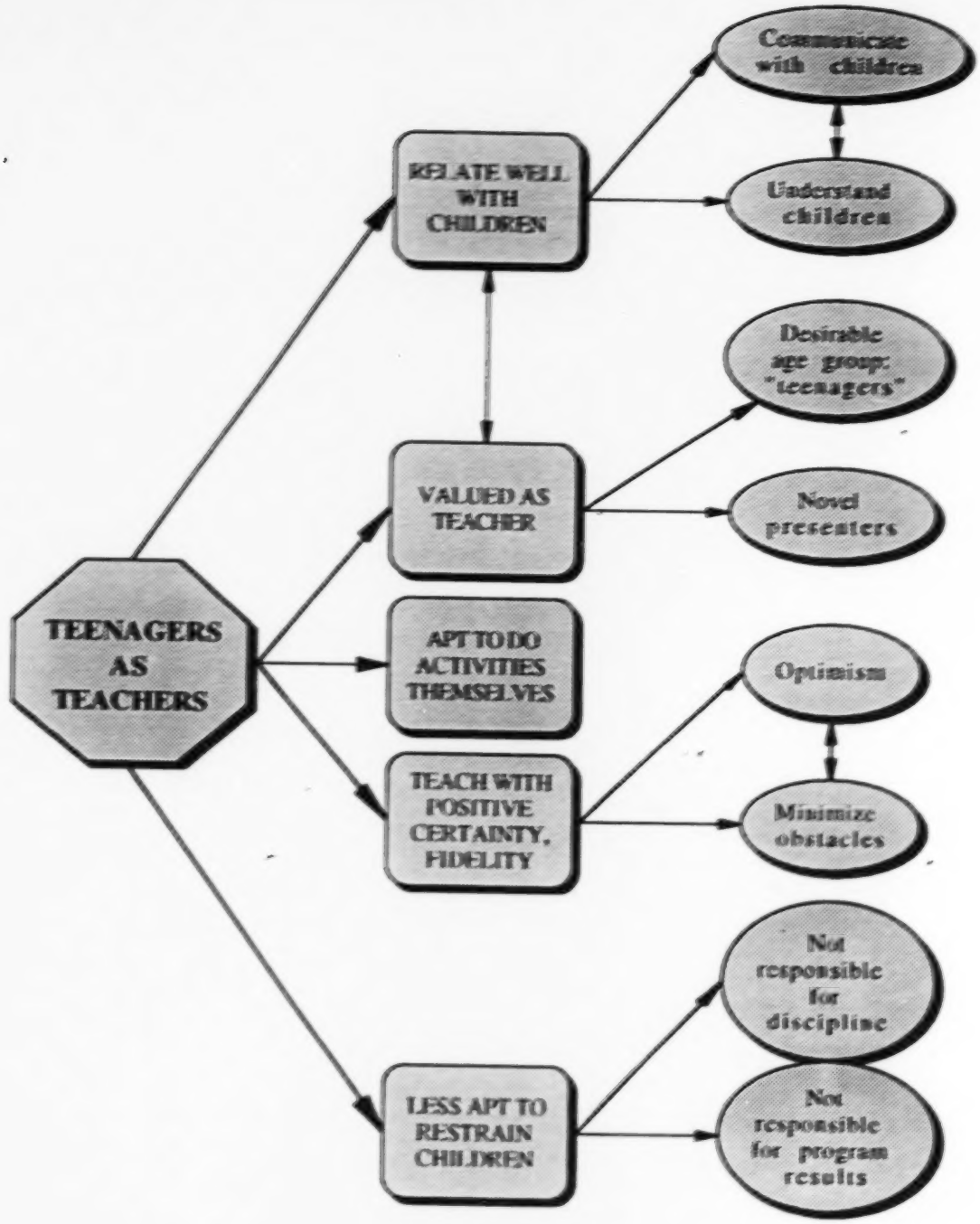

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FIGURE 1: Teenagers as Effective Teachers of Science